MODULE SPECIFICATION

The information contained in this module specification was correct at the time of publication but may be subject to change, either during the session because of unforeseen circumstances, or following review of the module at the end of the session. Queries about the module should be directed to the member of staff with responsibility for the module.

1.	**Module Title**	STATISTICAL AND LOW TEMPERATURE PHYSICS		
2.	**Module Code**	PHYS393		
3.	**Year**	200910		
4.	**Originating Department**	Physics		
5.	**Faculty**	Faculty of Science		
6.	**Semester**	First Semester		
7.	**Credit Level**	Level Three		
8.	**Credit Value**	15		
9.	**External Examiner**	Physics External Examiner		
10.	**Member of staff with responsibility for the module**	Dr KM Hock	Physics	K.M.Hock@liverpool.ac.uk
11.	**Module Moderator**	Dr S Burdin	Physics	S.Burdin@liverpool.ac.uk
12.	**Other Contributing Departments**			
13.	**Other Staff Teaching on this Module**			
14.	**Board of Studies**	Physics		
15.	**Mode of Delivery**	Lectures/Tutorials		
16.	**Location**	Main Liverpool City Campus		

		Lectures	**Seminars**	**Tutorials**	**Lab/Practicals**	**Fieldwork/Placement**	**Other**	**TOTAL**
17.	**Contact Hours**	32		4				36
18.							Non-contact hours	114
19.							TOTAL HOURS	150

		Lectures	**Seminars**	**Tutorials**	**Lab/Practicals**	**Fieldwork/Placement**	**Other**
20.	**Timetable (if known)**	Semester 1: Monday 10.00, Tuesday 10.00, Friday 12.00		Thursday 1.00, 2.00, 3.00 or 4.00 pm on a three week cycle			

21. Pre-requisites before taking this module (other modules and/or general educational/academic requirements):

PHYS253 and PHYS255

22. Modules for which this module is a pre-requisite:

None

23. Co-requisite modules:

None

24. Linked Modules:

25. Programme(s) (including Year of Study) to which this module is available on a mandatory basis:

26. Programme(s) (including Year of Study) to which this module is available on a required basis:

F303 (3 or 4)

27. Programme(s) (including Year of Study) to which this module is available on an optional basis:

MODULE DESCRIPTION

28. Aims

- To build on material presented in earlier Thermal Physics and Quantum Mechanics courses
- To develop the statistical treatment of quantum systems
- To use theoretical techniques to predict experimental observeables
- To introduce the basic principles governing the behaviour of liquid helium and superconductors in cooling techniques

29. Learning Outcomes

At the end of the module the student should have:

- Understanding of the statistical basis of entropy and temperature
- Ability to devise expressions for observeables, (heat capacity, magnetisation) from statistical treatment of quantum systems
- Understanding of Maxwell Boltzmann, Fermi-Dirac and Bose Einstein gases
- Knowledge of cooling techniques
- Knowledge and understanding of basic theories of liquid helium behaviour and superconductivity in cooling techniques

30. Teaching and Learning Strategies

Lectures to define the material, tutorials linked to lecture material to reinforce the quantitative aspects of the topics covered.

31. Syllabus

PHYS393

- Basic ideas, macrostate, microstates, averaging, distributions, statistical entropy
- Distinguisable particles, statistical definition of temperature
- Boltzmann distribution, partition function
- Calculation of thermodynamic functions
- Spin 1/2 solid, localised harmonic oscillators
- Gases
- States in boxes, example He gas
- Identical particles - fermions and bosons
- Microstates for gas - Fermi Dirac, Bose Einstein, Maxwell Boltzmann distributions
- Maxwell Boltzmann gases - speed distribution
- Diatomic gases - heat capacity. Heat capacity of H2.
- Fermi Dirac gases. Aplication to metals, He3.
- Bose Einstein gases. Application to He4, photons, phonons
- Cooling techniques - liquefaction of gases, Joule Kelvin effect, Liquefiers. 3He dilution refrigerator, Adiabatic demagnetisation, Nuclear demagnetisation
- Liquid He4 - superfluid he4. Two fluid model theories of He II
- Liquid He3. Experiment - ideas
- Superconductivity. Normal conductivity, basic properties of superconductors: Phenomenological models, two fluid model, London theory; Deductions for experiment. BCS theory; Recent developments - high Tc superconductors

(optional)

32. Recommended Texts

"Statistical Physics", Guenault...(optional)

"Statistical Mechanics - A Survival Guide," A. M. Glazer and J. S. Wark, Oxford University Press, 2001... (available as ebook in Liverpool University library).

"Matter and Methods at Low Temperatures," Frank Pobell. Springer; 2nd edition,2002. ..[Chapters 1, 5, 7 and 9] ...(available as ebook in Liverpool University library)

"Low Temperature Physics," C. Enss and S. Hunklinger, Springer, 2005...[Chapters 1, 6, 7, 8 and 11] ...(available as ebook in Liverpool University library)...(optional)

ASSESSMENT

33. EXAM	Duration	Timing (Semester)	% of final mark	Resit/resubmission opportunity	Penalty for late submission	Notes
Written Examination	3 hours	1	100	August resit for PGT students only. Yr3 and Yr4 students resit at the next normal opportunity.		

34. CONTINUOUS	Duration	Timing (Semester)	% of final mark	Resit/resubmission opportunity	Penalty for late submission	Notes